

## It's all relative: A validation of radiation quality comparison metrics

Chappell LJ<sup>1</sup>, Milder CM<sup>2\*</sup>, Elgart SR<sup>1</sup>, Semones EJ<sup>2</sup>

\*Presenting Author

<sup>1</sup>KBR Wyle

<sup>2</sup>NASA Johnson Space Center

Historically, the relative biological effectiveness (RBE) has been calculated to quantify the difference between heavy ion and gamma ray radiation. The RBE is then applied to gamma ray data to predict the effects of heavy ions in humans. The RBE is an iso-effect dose-to-dose ratio which, due to its counterintuitive nature, has been commonly miscalculated as an iso-dose effect-to-effect ratio. A paper recently published by Shuryak et al [1] described this second measure intentionally for the first time in 2017, referring to it as the radiation effects ratio (RER).

In this study, we utilized simulations to test the ability of both the RBE and the RER to predict known heavy ion effects. RBEs and RERs were calculated using mouse data from Chang et al [2], and the ability of the RBE and RER to predict the heavy ion data from which they were calculated was verified. Statistical transformations often utilized during data analysis were applied to the gamma and heavy ion data to determine whether RBE and RER are each uniquely defined measures. Scale changes are expected when translating effects from mice to humans and between human populations; gamma and heavy ion data were transformed to represent potential scale changes. The ability of the RBE and RER to predict the transformed heavy ion data from the transformed gamma data was then tested. The RBE but not the RER was uniquely defined after all statistical transformations. The RBE correctly predicted the scale-transformed heavy ion data, while the RER did not. This presentation describes potential implications for both metrics in light of these findings.

[1] Shuryak, I., et al (2017). Scaling Human Cancer Risks from Low LET to High LET when Dose-Effect Relationships are Complex. *Radiation Research*.

[2] Chang, P. Y., et al (2016). Harderian Gland Tumorigenesis: Low-Dose and LET Response. *Radiation Research*, 185(5), 449–460.